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CARBON STEEL FORGINGS, CLASS-3 ↑

1.0 GENERAL:

This specification governs the quality requirements of Carbon Steel Forgings, class 3. ↑

2.0 APPLICATION:

Suitable for general engineering purposes.

3.0 CONDITION OF DELIVERY:

Normalised/Normalised and tempered.

Rough machining of the forgings shall be carried out, unless otherwise specified in the BHEL order/drawing.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The forgings shall comply, in general with the requirement of the following National standards and also meet the requirements of this specification.

IS:2004: 1991	} Carbon Steel Forgings For General Engineering	↑
Gr. 3 (30C8),	} Purposes.	

5.0 DIMENSIONS AND TOLERANCES:

The dimensions and tolerances shall be as specified in the order/ drawing. Wherever these are not specified, specified, the machining allowances and tolerances shall be as specified below:

For finish machined drawings : 3 ± 1 mm

For rough machined drawings : ± 1 mm

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CS-1096

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Rev. No. 10	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt. 25.05.2007	Dt :	Year :	HARDWAR	Corp. R&D	JANUARY 1978

**6.0 MANUFACTURE:**

Forgings shall be manufactured from steel produced by the open hearth, electric or such other process as may be agreed to between BHEL and the manufacturer.

Steel shall be fully killed.

Sufficient discard shall be made from each ingot to ensure freedom from pipe, segregation and other defects.

The amount of hot working and finishing temperature shall be such as to ensure complete soundness and adequate uniformity of structure and mechanical properties after heat treatment. The forgings shall not be overheated.

The minimum reduction ratio when forgings are made out of ingots shall be 4:1.

For sizes above 250 mm ruling section, the minimum reduction ratio shall be 3.5:1

Note: Raw material like Ingots/Blooms/Billets required for forgings should be procured from BHEL approved sources along with test certificate."

7.0 HEAT TREATMENT:

Forgings shall be normalised / normalised and tempered at suitable temperature to achieve the mechanical properties specified.

Test pieces shall also be heat treated along with the forgings they represent.

8.0 FINISH:

As mentioned in the drawing.

9.0 FREEDOM FROM DEFECTS:

The forging shall be free from defects, such as cracks, fold, flakes, seams, segregation, nonmetallic inclusions and other defects which may affect the utility of the forging.

10.0 CHEMICAL COMPOSITION:

The melt analysis of steel and permissible variation in the composition of the forgings form the melt analysis shall be as follows:

Element	Melt analysis, percent		Permissible variation, percent
	Min.	Max.	
Carbon	0.25	0.35	± 0.03
Silicon	0.15	0.35	± 0.03
Manganese	0.60	0.90	± 0.04
Sulphur	---	0.040	+ 0.005
Phosphorus	---	0.040	+ 0.005



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Notes:

1. Elements not quoted above shall not be added to the steel, other than for the purpose of finishing the heat and shall not exceed the following limits:

Element	Percent, max.
Nickel	0.30
Chromium	0.30
Copper	0.25
Molybdenum	0.15
Vanadium	0.05
Tin	0.05
Boron	0.0003

2. When steel is aluminium killed or killed with both aluminium and silicon, the requirements of minimum silicon content shall not apply. For aluminium killed steel the total aluminium content shall be within 0.02 to 0.05 percent.
3. $Mo \leq 0.15\%$, limiting to meeting conditions of $Cr + Mo + Ni = 0.5\%$.

11.0 TEST SAMPLES:

- 11.1 Unless otherwise specified in the order/drawing, test samples shall be taken from each melt and each heat treatment batch. Test samples should be cut from the heat treated forgings by cold process only and shall not undergo further heat treatment.

Test samples shall be taken from locations indicated on the drawing, leaving enough material, if required for testing at BHEL's end, integral with forgings.

The samples shall be cylindrical or rectangular in shape and cut at a distance of 12.5mm below the heat treated surface.

- 11.2 When integral test pieces are not called for, a test sample, having similar reduction ratio and heat treatment, as the forgings it represents, shall be provided per heat, per heat treatment batch, for check testing at BHEL, along with the forgings. The samples shall be properly identified and correlated with the Heat/Heat treatment Batch No./ Test Certificate No. Test samples shall be taken, at a distance of 12.5mm below the heat-treated surface.

- 11.3 Test samples shall generally be taken in the longitudinal direction. However, for economic reasons or where the size/ configuration does not permit the same, test samples may be taken in the transverse or radial direction.

**12.0 MECHANICAL PROPERTIES:**

The test pieces, after being heat treated as per clause 7.0 above, shall show the following properties upto a limiting ruling section of 800 mm. Properties for thicker sections shall be subject to agreement between BHEL and the manufacturer. Test methods are specified below:


- 12.1 Tensile test : IS:1608
 12.2 Hardness test (Brinell) : IS:1500
 12.3 Charpy Impact Value (2mm U-Notch) : IS:1499

This test applicable for forgings of sizes above 16mm only.

Property	Sample (See Cl.11.3)	Limiting ruling section, mm			
		Upto & incl 100	>100 & upto 300	> 300 & upto 500	>500 & upto 800
Tensile strength N/mm ²	Longitudinal/	490	470	450	450
	Transverse/ Radial/Tangential	490	470	450	450
Yield strength min, N/mm ²	Longitudinal/	270	245	230	220
	Transverse/ Radial/Tangential				
Elongation on 5.65 √So gauge length percent, min	Longitudinal	21	19	18	17
	Transverse	10	9	8	7
	Radial	14	12	11	10
	Tangential	16	14	13	12
Reduction in area, percent min.	Longitudinal	42	40	35	32
	Transverse	25	24	22	20
	Radial	27	26	24	22
	Tangential	34	32	32	30
*Hardness, Brinell, HB	—	140-192	140-192	135-190	135-190
Charpy Impact Value (2mm, U-Notch) min., Joules	Longitudinal	35	31	27	23
	Transverse	18	16	14	12
	Radial	21	19	17	15
	Tangential	26	23	20	17

Note: 1. Unless otherwise stated on the order/drawing, small forgings of non-critical nature weighing less than 300kg shall be accepted on the basis of chemical composition and hardness.

* 2. Hardness test can be conducted only, when tensile test can not be performed.

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13.0 ULTRASONIC TESTS: ↑		
13.1 For forgings ordered by BHEL, Hyderabad: Unless other wise specified on the drawing, ultrasonic test shall be carried out as per BHEL standard AA 085 01 18 and norms of acceptance shall be as per category 2.		
13.2 For forgings ordered by other units: If specified on the drawing/order, ultrasonic test shall be carried out as per BHEL standard AA 085 01 18 and norms of acceptance shall be as per category 2, unless otherwise specified.		
14.0 ADDITIONAL TESTS:		
If specified in the drawing/order, the following tests shall be conducted:		
14.1 Bend Test (Longitudinal):		
The test pieces (230mm long and 32 mm square with edges rounded off, where the dimensions permit) shall be capable of being bent cold by direct pressure without fracture, until the sides are parallel, round a mandrel having a diameter of 44 mm when tested as per IS:1599.		
14.2 Magnetic particle test.		
14.3 Any other tests: Norms of acceptance shall be as specified in the drawing/order.		
15.0 SCOPE OF THIRD PARTY INSPECTION:		
Wherever, separate quality plan is not attached, the scope of third party inspection shall be as follows:		
<ol style="list-style-type: none"> 1. Review of supplier's declared chemical composition. 2. Selection of test samples for mechanical tests and witness of mechanical tests. 3. Witness of Non-destructive tests as applicable. 4. Review of HT charts. 5. Dimensional inspection. 		
16.0 TEST CERTIFICATE:		
Three copies of test certificates shall be supplied unless otherwise stated in the order, preferably in the test certificate format annexed to this specification (Annexure 1).		
In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.		
The following details shall be furnished in the test certificate:		
<ol style="list-style-type: none"> i) Reduction ratio ii) Dimensional Inspection. iii) Chemical composition including trace elements. iv) Results of mechanical tests. v) Results of Ultrasonic test vi) Details of heat treatment vii) Results of additional tests called for in the drawing/order. 		

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17.0 PACKING & MARKING:

Forgings shall be suitably packed to prevent corrosion and damage during transit.

Machined surfaces shall be properly protected with anticorrosive compounds.

Each package or forging (when supplied separately) shall be legibly marked with the following information:

AA 193 32 : Carbon Steel Forgings, Class 3

BHEL Order No.

Suppliers Name

Consignment/ Identification No.

Batch No.

Weight.

18.0 REFERRED STANDARDS (Latest publications Including Amendments):

1) AA 085 01 18
5) IS: 1608

2) IS:1499
6) 2004

3) IS:1500

4) IS:1599



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ANNEXURE-1: RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS

SUPPLIER'S NAME AND ADDRESS
TEST CERTIFICATE FOR FORGINGS

1. Customer: 2. TC No. & Date: 3. PO No.: 4. Process of Heating Ingot: 5. Deposition Process: 6. Forging Method: 7. BHEL's Preference for Approval of Bloom: 8. Discard Top _____ % Bottom _____ %	9. Reducer Ratio } Ingot to Bloom } Bloom to Blank 10. Batch No.: 11. Heat/Melt No.: 12. Sped. No.: 13. Test Bar Size & Nos. 14. Supplier of the ingot/billet/ Bloom and TC reference
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15. FORGINGS COVERED BY TEST CERTIFICATE

S.No	Drawing No. & Item No.	Dimension	Quantity & Weight

16. CHEMICAL COMPOSITION (PERCENT)

Element	C	Si	Mn	S	P	Bend Test		
						Angle of bend	Dis of metal	Result
As Per Specn.	Min.							
	Max.							
Actual Values								

17. HEAT TREATMENT
(To be accompanied by Recorder Chart, Whenever called for)

Condition	Heating Rate, °C/hr.	Temp. °C	Soaking Time, Hrs.	Cooling Rate, °C/hr.	Cooling Medium

18. MECHANICAL PROPERTIES

As Per Specn.	T.S. N/mm ²	Y.S. 0.5-0.2% Proof N/mm ²	% Elongation 5.65√So G.	% RA Min.	Hardness SHN (Min. 3 values)	Impact Value Joules	Bend Test		
							Angle of bend	Dis of metal	Result
Min.									
Max.									
Actual Values									

19. SURFACE FINISH (When called for in the order/drg.)

20. DIMENSIONAL INSPECTION

21. NON-DESTRUCTIVE TESTS

Nature of Test	Acceptance level	Instrument used	Range	Results	Any other detail
Ultrasonic					
Radiographic					
Dye penetrant/ Magnetic Particle					

22. METALLOGRAPHIC EXAMINATION
(To be conducted & called for and photo micrographs to be attached along with a report)

Location of Sample	Echant used	Metallograph	Constituent observed	Relative %
Microstructure	Macroetch	Inclusion Rating		

23. OTHER TESTS IF ANY (MICROSCOPIC, SULPHUR PRINTS, ETC)

24. IDENTIFICATION OF FORGINGS AS PER PURCHASE SPEC

We hereby certify that the items mentioned above have been tested and inspected in our presence and are found to be in accordance with drawings, specifications and purchase order.

SIGNATURE, NAME & SEAL OF THE INSPECTING OFFICER DATE	SIGNATURE, NAME & SEAL OF THE CHIEF OF QUALITY CONTROL/ CHIEF METALLURGIST OF THE SUPPLIER DATE
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INSTRUCTIONS

- Details of all heat treatment processes carried out should be furnished sequentially in 17.
- Test certificates are to be furnished as per Purchase order and specification, in A4 size preferably in transparent paper.
- All the entries including signature should be in black colour ink.
- If testing is done by outside agencies, the original TCs shall be furnished.
- The actual TC may run into more than one A4 size paper, if needed, to facilitate filling up of details.